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RADIOGEOLOGY.—*Lead isotopes and the problem of geologic time.*[1]

CHARLES SNOWDEN PIGGOT, Geophysical Laboratory, Carnegie Institution of Washington.

This paper seeks to point out a means of experimentally measuring the lead which has been actually produced by the radioactive disintegration of uranium alone, and thereby to provide definite figures for the uranium-lead ratio in its application to the determination of geologic time.

Of the various methods which have been tried or suggested for obtaining a more or less accurate estimate in terms of years of geologic time, that one which uses the uranium-lead ratio is by far the most promising and the most definite. This method is based upon the fact that uranium and thorium are the original elements which produce, by spontaneous disintegration, the long series of radioactive substances which undergo radioactive changes one into the other until finally they produce in each case lead. This lead appears to have no further radioactivity[2] and is assumed to be the final and end product of these radioactive changes.

The time required for these changes to take place has been accurately determined in the case of the uranium series and with much less accuracy for the thorium series, so that we now know just how many years are required for a given amount of uranium to change into its corresponding amount of lead.

It would seem, therefore, that all that is needed to determine the age of a mineral containing considerable amounts of uranium or thorium or both, together with their corresponding lead, would be a careful

[1] Received April 19, 1928.

[2] However, the term "radioactive lead" has come into the literature, and signifies that lead which is known to have been produced by radioactive means.

chemical analysis to determine the amounts of these various constituents, and the substitution of the figures obtained in a suitable formula.

However, as is usually the case, the actual practice is not so simple as the theory would indicate. The necessary chemical analysis is exceedingly difficult and tedious, and the amounts of the significant elements obtained are so small that minute analytical errors have disproportionately great effects upon the ultimate result. The extrapolation in terms of years over vast geologic ages is so great that legitimate analytical errors may cause a difference of hundreds of thousands of years in the indicated age.

This aspect of the problem must depend upon the completeness of the analytical separations and upon the care and skill of the analyst.

But the chemical analysis alone, however satisfactory it may be as a mineral analysis, cannot show whether or not the lead obtained is all of radioactive origin, or whether it came partly from uranium, partly from thorium, or partly from some other source.

The possibility of enrichment by lead from some non-radioactive source must be considered, and also the partial removal of the lead already radioactively produced. These considerations, however, are outside the scope of this paper.

But assuming that the above requirements have all been satisfactorily met, there yet remain two grave uncertainties which make this method unsound and unsatisfactory in its application. They are the most troublesome uncertainties inherent in this procedure and as yet there has been no direct experimental method for dealing with them. They are:

(1) The uncertainty associated with the disintegration of the thorium series—the time required and the amount and origin of the lead produced.

The thorium series of radioactive disintegrations has not yielded to experimental examination as readily as the uranium series has. Consequently there is considerable uncertainty associated with the time required for a given amount of thorium to form its corresponding amount of lead. Also the quantity of lead produced by a given quantity of thorium is not known with satisfactory accuracy.

Therefore the presence of thorium in a mineral to be used for an age determination injects a considerable element of uncertainty into the result, and as some thorium is always present this cannot be avoided. The formula now used contains a corrective factor to take care of the thorium content, but it is admittedly unsatisfactory.

(2) The fact that there is no actual measure of that proportion of the total lead which is known to have been produced from the uranium alone.

If this latter could be determined by actual experimental measurement the thorium uncertainty could be disregarded and the only other uncertainty which would remain inherent and unmeasured in this method would be the existence of possible isotopes of uranium which might have disintegrated more rapidly in the past than the uranium which we know today.

If the lead in any given mineral being studied could be obtained in sufficient quantity and converted into some compound capable of giving lines in the mass-spectrograph, and if the intensity of these lines could be accurately measured, we would then have a direct experimental method for determining the actual amount of uranium lead present. The position of the line would identify it with the uranium-lead isotope and its relative intensity would furnish a measure of its relative amount, and since the actual weights of uranium and lead would be known from the chemical analysis we would then have all the information necessary for a direct comparison of the amounts of uranium and uranium-derived lead. Any other isotopes of lead could be disregarded and no reliance need be placed upon assumed proportions figured from atomic weight determinations of lead associated with uranium and thorium, while any enrichment by ordinary lead would probably be revealed by an abnormally intense "207 line."

It was with these considerations in mind that the author, in October, 1926, wrote to Dr. F. W. Aston, F.R.S., and requested his criticism and coöperation in a proposed plan to convert samples of lead into some volatile organic compound such as lead tetramethyl, lead tetraethyl, lead phenyl, etc., and to endeavor to secure with it the identification and determination of any isotopes by means of the mass-spectrograph. After some correspondence it was decided that lead tetramethyl was the most promising material, and that the first efforts should be directed toward a separation and identification of the isotopes of ordinary laboratory lead.

For this purpose the author took a sample[3] of lead tetramethyl to Dr. Aston in July, 1927, and shortly thereafter Dr. Aston carried out several experiments with this material. The results were most

[3] Prepared for him by Mr. S. C. WITHERSPOON of the U. S. Chemical Warfare Service.

satisfactory and were first published by Dr. Aston in a brief note to *Nature* dated July 30, 1927.[4]

The experiments demonstrated very clearly the existence of the three anticipated isotopes, namely, those of masses 206, 207, and 208 in the approximate ratios of 4, 3, and 7 respectively, and also revealed the existence of other isotopes of lead, present in very small proportions, of which 203, 204, and 205 were indicated, and 209 was reasonably certain.

The isotopes having been thus definitely separated and identified, the next step was to do the same for "radioactive lead," i.e., lead which had been formed mostly or entirely by the radioactive disintegration of uranium and thorium.

For this purpose the author secured some very pure Norwegian bröggerite, a mineral which contains considerable proportions of uranium and lead but a very small proportion of thorium. This material was carefully analyzed[5] for uranium, thorium, and lead and a sufficient quantity "worked up" to yield about 15 grams of "radioactive lead" chloride.

Five grams of this material was converted into lead tetramethyl[6] and sent in a sealed tube to Dr. Aston. Unfortunately, this tube was broken in transit and the material lost, but another quantity of radioactive lead tetramethyl has been prepared and it is proposed to try this in the mass-spectrograph this summer.

Meanwhile Dr. Aston has been developing an instrument for accurately measuring the relative intensities of the lines on the photographic plates from his mass-spectrograph. This will eliminate the personal equation from this determination and render it capable of exact repetition and comparison.

Since there is very little thorium, relative to uranium, in this bröggerite it is anticipated that these next experiments will show a very heavy line at 206, a very light one at 208, and possibly none at all at 207. It will be interesting to see whether any of the other isotopes show up stronger from this radioactive lead than they did with the ordinary lead tetramethyl.

From the data obtained from these two series of lead-isotope measurements we hope to be able:

[4] Nature **120**: 224. 1927.

[5] By Dr. C. N. FENNER of the Geophysical Laboratory.

[6] See note 3.

(1) To determine directly the uranium:uranium-lead ratio for this sample of bröggerite and thereby secure a reliable estimate of its age.
(2) To determine definitely the thorium:thorium-lead relationships.
(3) To throw some light on the other isotopes of lead and their origin.

BOTANY.—*New plants from Central America.*—XIII.[1] PAUL C. STANDLEY, U. S. National Museum.

The Central American plants here proposed as new belong to the family Rubiaceae. Seven of them are representatives of the vast genus *Psychotria*. Formerly it was believed that this group was poorly represented in Central America, but continued exploration suggests that the Central American species may finally equal in number those known from the Antilles.

Psychotria Alfaroana Standl., sp. nov.

Erect shrub 30–60 cm. high, usually simple but sometimes with a few short branches above, the stems terete or obtusely quadrangular, the internodes mostly short, about 1 cm. long, or sometime elongate; stipules deciduous, 8–18 mm. long, often ciliate, the base oblong-ovate, deeply cleft to below the middle, the lobes linear, long-attenuate; leaves opposite, the petioles 1–2 cm. long, stout, often marginate nearly to the base; leaf blades obovate-oblong to elliptic, 11.5–26 cm. long, 3.5–9 cm. wide, acute or abruptly acute, usually long-attenuate to the petiole and decurrent, sometimes merely acutely cuneate at base, thick-membranaceous, deep green above (often glaucescent when dry), glabrous, usually marked on both surfaces with numerous short linear raphids, beneath somewhat paler, often minutely puberulent on the nerves, at least when very young, but soon glabrate, the costa stout, prominent, the lateral nerves slender, about 13 on each side, divergent at a wide angle, arcuate, anastomosing rather remote from the margin, the intermediate nerves inconspicuous; inflorescence terminal, cymose-umbellate, the primary peduncles several, 4–7 mm. long, sordid-puberulent or glabrate, each bearing few or numerous flowers, these borne on stout puberulent pedicels 2–4 mm. long (in fruit); whole inflorescence compact, subglobose, in fruit 2–4.5 cm. broad, borne on a stout erect peduncle 1.5–3.5 cm. long; bracts deciduous; fruit at maturity red, ellipsoid, 8–10 mm. long, 5–6 mm. thick, glabrous; pyrenes 2, sharply 3 or 4-costate dorsally, plane on the inner surface.

Type in the U. S. National Herbarium, no. 1,253,966, collected in wet forest at El Arenal, Province of Guanacaste, Costa Rica, altitude 500 meters,

[1] Published by permission of the Secretary of the Smithsonian Institution. For the last preceding paper of this series see this JOURNAL **18**: 178. 1928. Received December 27, 1927.

January 18, 1926, by Paul C. Standley and Juvenal Valerio (no. 45179). The following collections are referable here:

COSTA RICA: El Arenal, *Valerio* 62, *Standley & Valerio* 45200. El Silencio, Guanacaste, alt. 750 m., *Standley & Valerio* 44585, 44620, 44603, 44771. Los Ayotes, near Tilarán, Guanacaste, alt. 700 m., *Standley & Valerio* 45359. La Tejona, near Tilarán, Guanacaste, alt. 600 m., *Standley & Valerio* 45845, 45855. Pejivalle, Prov. Cartago, alt. 900 m., *Standley & Valerio* 46985.

The species is named for Don Anastasio Alfaro. It is an unusually well marked *Psychotria*, easily recognized by its dwarf habit and condensed globose inflorescence.

Psychotria haematocarpa Standl., sp. nov.

Shrub 1–2.5 m. high, the branches slender, terete or the younger ones obtusely quadrangular, glabrous, the internodes mostly about 1 cm. long but often much longer; stipules persistent, green, united to form a very short sheath, this bicuspidate on each side, the cusps linear-filiform, 3–4 mm. long, glabrous; leaves opposite, the petioles slender or stout, 3–8 mm. long, not sharply differentiated from the blade, glabrous or sparsely puberulent; leaf blades oblong-elliptic, broadest at the middle, 8.5–14 cm. long, 2.5–5 cm. wide, abruptly or gradually long-acuminate, with narrow, often falcate, attenuate-acute acumen, at base gradually or abruptly acute or attenuate and decurrent upon the petiole, membranaceous, glabrous, somewhat lustrous, deep green above, the costa prominent, beneath slightly paler, the costa and lateral nerves slender, prominent, the lateral nerves about 9 on each side, divergent at a very broad angle, slightly curved, irregularly anastomosing remote from margin, pale, the intermediate nerves prominulous, laxly reticulate, the margins plane; inflorescences terminal, capitate, dense, few-flowered, the peduncles 3–4 mm. long, green, puberulent or glabrate; outer bracts lance-linear, acute, green, glabrous, 1.5–2 mm. long; flowers sessile or nearly so; fruit globose, bright red, glabrous, 5 mm. long; pyrenes obtusely 5-costate dorsally, the inner surface plane, not grooved.

Type in the U. S. National Herbarium, no. 1,254,627, collected in moist forest at Naranjos Agrios, near Tilarán, Guanacaste, Costa Rica, altitude 600 to 700 meters, January 29, 1926, by Paul C. Standley and Juvenal Valerio (no. 46407). One other collection is referred here:

COSTA RICA: Pejivalle, Prov. Cartago, alt. 900 m., *Standley & Valerio* 47194.

The relationship of this plant is evidently with *P. involucrata* Swartz, a species widely dispersed in tropical America. The latter differs in the strongly ascending nerves of the leaves, and in the ample, usually branched inflorescence with large bracts.

Psychotria sylvivaga Standl., sp. nov.

Shrub 1–3 m. high, the branches stout, the older ones brownish, obtusely quadrangular, the young branches minutely puberulent or glabrate, 1.5–4 cm. long; stipules distinct, caducous, broadly ovate, 8–10 mm. long, thin, brown, glabrous, marked with numerous short linear raphids; leaves opposite, the petioles slender or stout, 0.8–2.5 cm. long, glabrous; leaf blades oblong-oblanceolate or rarely elliptic-oblong, nearly always broadest above the

middle, 9–17 cm. long, 2.5–5.5 cm. wide, usually abruptly acuminate or short-acuminate, with obtuse tip, gradually long-attenuate to the base and decurrent, thick-papyraceous, deep green above, lustrous when fresh, glabrous, narrowly sulcate along the costa, beneath slightly paler, usually sparsely and obscurely short-barbate in the axils of the lateral nerves, the costa and lateral nerves slender, prominent, the lateral nerves 11–16 on each side, divergent at a wide angle, arcuate, irregularly and laxly anastomosing near the margin, the intermediate nerves obscure; inflorescence terminal, cymose-paniculate, lax, many-flowered, the peduncle 5.5–7 cm. long, erect; panicles 4.5–9.5 cm. long, 5.5–11 cm. wide, the primary branches opposite, divaricate, minutely puberulent, the terminal cymes few-flowered, umbelliform, the pedicels in anthesis 1–3 mm. long, puberulent, in fruit sometimes 8 mm. long; bracts minute, triangular, green, brown-ciliate, caducous, their scars brown-pilose; hypanthium globose-turbinate, 1–1.5 mm. long, minutely puberulent; calyx 1 mm. long, shallowly 5-dentate or subtruncate, the teeth broadly triangular, green, obtuse, minutely ciliolate; corolla salverform, greenish white, glabrous, the tube 5 mm. long, 1.2 mm. thick, the lobes triangular-ovate, 1.5 mm. long, obtuse; fruit green, globose, 5-6 mm. long, glabrous; pyrenes 2, obtusely 5-costate dorsally, plane on the inner surface, the seeds not grooved.

Type in the U. S. National Herbarium, no. 1,306,274, collected in wet forest at Yerba Buena, northeast of San Isidro, Province of Heredia, Costa Rica, altitude 2,000 meters, February 28, 1926, by Paul C. Standley and Juvenal Valerio (no. 49989). The following collections are conspecific:

COSTA RICA: Wet oak and bamboo forest near Laguna de la Escuadra, northeast of El Copey, Prov. San José, alt. 2,200 m., *Standley* 41974, 41924. Laguna de la Chonta, northeast of Santa María de Dota, Prov. San José, alt. 2,000 m., *Standley* 42212.

Psychotria chiriquina Standl. differs from the present plant in its smaller leaves, glabrous inflorescence, and short corolla. *P. Jimenezii* Standl., which also is related, has nearly sessile leaves, a short corolla, and more evidently pubescent inflorescence.

Psychotria eurycarpa Standl., sp. nov.

Shrub or small tree, 2.5–5 m. high, the branches stout, green, glabrous, the internodes 1–8 cm. long; stipules persistent, green, glabrous, forming an intrapetiolar ring 1–2 mm. long, this cuspidate between the petioles, the cusp subulate, 1–2.5 mm. long; leaves opposite, the petioles stout, 4–18 mm. long, glabrous; leaf blades chiefly elliptic or broadly elliptic, rarely oblong-elliptic, broadest at the middle, 7.5–15.5 cm. long, 2.5–9 cm. wide (averaging about 9.5 by 4.5 cm.), abruptly acuminate or short-acuminate, with acuminate tip, sometimes rounded at apex and short-cuspidate, at base varying from acute to narrowly rounded, sometimes short-decurrent, papyraceous to thin-coriaceous, glabrous, deep green and lustrous above, the costa elevated, beneath paler, lustrous, the costa and lateral nerves rather stout, pale, prominent, the lateral nerves 6 or 7 on each side, divergent at a wide angle, strongly arcuate and directed upward, extending nearly to the margin and there irregularly anastomosing, the intermediate nerves prominulous, pale, coarsely reticulate; inflorescences terminal, cymose-paniculate, the peduncle 0.7–3 cm. long, stout, erect; panicles corymbiform, 2–3 cm. long, usually broader than long, the primary branches green, compressed, glabrous or minutely pulverulent, divaricate or usually ascending, densely few-flowered, the

flowers sessile; bracts persistent, green, inconspicuous, linear to triangular, 1–2 mm. long; hypanthium globose-turbinate, 1 mm. long, pulverulent; calyx 0.8 mm. long, shallowly 5-dentate or subtruncate, the teeth broadly triangular, broader than long, green; corolla in bud 4–6 mm. long, pulverulent; fruit at first green, at maturity blue-black, subglobose, 9–12 mm. long, glabrous, shallowly bisulcate; pyrenes 2, sharply 5-sulcate dorsally, deeply and narrowly sulcate on the flat inner surface from base to apex.

Type in the U. S. National Herbarium, no. 1,254,544, collected in moist forest at Quebrada Serena, southeast of Tilarán, Guanacaste, Costa Rica, altitude about 700 meters, January 27, 1926, by Paul C. Standley and Juvenal Valerio (no. 46237). As representative of the species may be listed several other collections:

COSTA RICA: Forests of San Pedro, near San Ramón, alt. 1,300–1,400 m., *Tonduz* 17657. Finca Montecristo, near El Cairo, Prov. Limón, *Standley & Valerio* 48435. El Arenal, Guanacaste, *Valerio* 98.

The species is well marked by the unusually large fruit.

Psychotria orchidearum Standl., sp. nov.

Small erect epiphytic shrub 15–30 cm. high, glabrous throughout; older branches stout, 3–4 mm. thick, ochraceous, rimose, the younger ones quadrangular, ochraceous, lustrous, the internodes mostly 3–6 mm. long; stipules intrastipular, forming an indurate truncate sheath 1–2 mm. long; leaves opposite, the petioles slender, 2–4 mm. long, or often nearly obsolete; leaf blades elliptic or oblong-elliptic, 15–32 mm. long, 6–12 mm. wide, obtuse or acute, apiculate, usually cuneate-acute or attenuate at base, rarely obtuse, thick and fleshy, deep green above, the venation obsolete, beneath paler, the costa evident but the other nerves obsolete; inflorescence terminal, cymose-paniculate, lax, few-flowered, the peduncle slender, 10–13 mm. long, erect, the panicles 1.5 cm. long and broad or smaller, the branches very slender; bracts persistent, greenish, linear or linear-subulate, 1–3 mm. long; pedicels slender, mostly 3–5 mm. long; hypanthium obovoid, 1 mm. long; calyx 1 mm. long, 4-dentate to the middle, the teeth triangular, acute; fruit subglobose, 3 mm. long, red, shallowly bisulcate laterally; pyrenes 2, smooth dorsally, the inner face slightly concave, deeply and narrowly sulcate from base to apex.

Type in the U. S. National Herbarium, no. 1,306,503, collected on tree in wet forest on Cerros de Zurquí, northeast of San Isidro, Province of Heredia, Costa Rica, altitude about 2,200 meters, March 3, 1926, by Paul C. Standley and Juvenal Valerio (no. 50863). No. 50757, from the same locality, represents the same species.

Psychotria orchidearum is closely related to *P. Maxonii* Standl., a common plant of the same region. *P. Maxonii* has long slender branches and is usually a larger plant; its leaves are much narrower than those of *P. orchidearum*, being chiefly linear-lanceolate.

Psychotria grandistipula Standl., sp. nov.

Shrub 3 m. high, the branches slender, subterete, green, very minutely puberulent, the internodes 1.5–4.5 cm. long; stipule one at each node, caducous, forming a sheath about the young leaves, cleft on one side, 3–4.5 cm. long, long-attenuate to a subulate apex, thin, brown, glabrous; leaves opposite, the petioles slender, 1.5–4 cm. long, minutely puberulent; leaf blades

lance-oblong to oblong-ovate or elliptic, 5.5–14 cm. long, 2.2–6 cm. wide, abruptly long-acuminate or cuspidate-acuminate, with attentuate acute tip, at base usually very obtuse to truncate but sometimes (even on the same branch) acute, thick-membranaceous, deep green on the upper surface, glabrous, the venation not elevated, beneath scarcely paler, minutely puberulent on the nerves, the costa and lateral nerves slender, elevated, the lateral nerves 9–14 on each side, ascending or the lowest divaricate, slightly arcuate, extending nearly to the margin, there laxly and irregularly anastomosing, the intermediate nerves obsolete; inflorescences terminal, sometimes appearing lateral by the continued growth of the main axis, cymose-paniculate, usually sessile, 4–13 cm. long, lax, many-flowered, the branches slender, minutely puberulent, divaricate or ascending; bracts caducous; pedicels 3–12 mm. long, straight, minutely puberulent; calyx persistent on the fruit, less than 1 mm. long, shallowly and remotely 5-dentate; fruit subglobose, bright red, 7 mm. long, glabrous; pyrenes 2, obtusely 5-costate dorsally; seeds narrowly sulcate on the inner surface from base to apex.

Type in the U. S. National Herbarium, no. 1,253,164, collected in moist forest near Santa María de Dota, Province of San José, Costa Rica, altitude about 1,600 meters, December 26, 1925, by Paul C. Standley and Juvenal Valerio (no. 43268). Additional collections are at hand, as follows:

COSTA RICA: Santa María, *Standley* 42402, 41806; *Standley & Valerio* 43187, 44098. La Colombiana Farm, Prov. Limón, alt. 70 m., *Standley* 36871.

The last specimen cited has no stipules and may not belong here, although it does not appear to differ essentially in other respects from the collections made at Santa María. It is rather unusual to find in the wet coastal forest a species that grows in such a high and comparatively dry region as that of Santa María.

Psychotria grandistipula is unique among the Costa Rican species of the genus in its exceptionally developed stipules.

Palicourea vestita Standl., sp. nov.

Shrub 1.5–2.5 m. high, the branches slender or stout, subterete, densely villous with short slender spreading yellowish many-celled hairs, the internodes 1.5–7.5 cm. long; stipules persistent, green, united to form a sheath 5 mm. long, this truncate, densely short-villous, bicuspidate on each side, the cusps linear, erect, 5–7 mm. long, stiff, attenuate to the apex, puberulent; leaves opposite, the petioles stout, 1.5–3 cm. long, densely short-villous or tomentulose; leaf blades lance-oblong, broadest at or sometimes slightly above the middle, 10–18 cm. long, 2.5–6 cm. wide, rather abruptly acuminate or long-acuminate, with narrow acute tip, narrowed to the acute or obtuse base, thick-membranaceous, bright green above, short-villous along the costa, beneath slightly paler, densely villous on the nerves with short slender yellowish spreading hairs, elsewhere velutinous-pubescent or sometimes glabrate, the costa stout, elevated, the lateral nerves slender, prominent, about 20 on each side, arcuate-divaricate, irregularly anastomosing close to the margin; inflorescence terminal, cymose-paniculate, many-flowered, narrowly pyramidal, 7–9 cm. long, the peduncle stout, 2.5 cm. long, the branches stout, reddish green, divaricate at right angles, densely pubescent; bracts green, linear, 2–4 mm. long; pedicels 2–5 mm. long, stiff, hirtellous; calyx lobes 5, persistent on the fruit, 1 mm. long, triangular, acute, hirtellous;

fruit blue, obovoid-globose, 5 mm. long, slightly compressed laterally and bisulcate, hirtellous; pyrenes 2, each with 3 broad rounded dorsal costae.

Type in the U. S. National Herbarium, no. 1,253,015, collected in wet oak forest near Quebradillas, about 7 km. north of Santa María de Dota, Prov. San José, Costa Rica, altitude about 1,800 meters, December 24, 1925, by Paul C. Standley (no. 42909).

Among the Costa Rican species of *Palicourea* this may be recognized by the copious pubescence of all parts, and by the numerous lateral nerves of the leaves.

Palicourea macrocalyx Standl., sp. nov.

Shrub 2 m. high, glabrous throughout, the young branches green, subterete, the internodes 2.5–4.5 cm. long; stipules green, persistent, 6–9 mm. long, cleft nearly to the base, the lobes triangular-oblong, 2–3 mm. wide, attenuate to the acute apex; petioles slender, 2–2.5 cm. long; leaf blades elliptic-oblong, 8–12 cm. long, 3.3–5 cm. wide, abruptly short-acuminate, with obtuse tip, at base broadly obtuse to acutish, subcoriaceous, somewhat lustrous, the costa and lateral nerves prominent on both surfaces, the costa stout, the lateral nerves about 14 on each side, divaricate, strongly arcuate, extending nearly or quite to the margin, the intermediate nerves prominulous, reticulate; inflorescence terminal, cymose-paniculate, much branched, dense, many-flowered, about 6 cm. long and broad, the peduncle 5 cm. long, the branches dark purplish; bracts oblong to broadly ovate, 4–5 mm. long, green, obtuse or rounded at apex; pedicels 4–6 mm. long, jointed at apex; hypanthium turbinate, 2 mm. long; calyx 5 mm. long, pale yellow, 5-lobate nearly to base, the lobes ovate, narrowed to the obtuse apex, conspicuously 3-nerved; corolla pale yellow, the tube 9 mm. long, 1.5 mm. thick, the 5 lobes broadly triangular-ovate, 2–5 mm. long, obtuse, spreading.

Type in the U. S. National Herbarium, no. 1,306,801, collected in wet forest on Cerro de las Lajas, north of San Isidro, Province of Heredia, Costa Rica, altitude about 2,200 meters, March 7, 1926, by Paul C. Standley and Juvenal Valerio (no. 51611).

Among the Central American species of *Palicourea* this may be recognized easily by the unusual development of the calyx.

Palicourea pauciflora Standl., sp. nov.

Shrub or small tree, the branches green, the older ones terete, the young ones obtusely quadrangular, the internodes 1–3.5 cm. long, densely and minutely puberulous; stipules 4–5 mm. long, green, persistent, distinct or nearly so, bilobate nearly to the base, the lobes narrowly triangular, narrowed to the obtuse apex, minutely puberulous; petioles slender, 5–15 mm. long, puberulent; leaf blades elliptic-oblong, 4–7 cm. long, 1–2.2 cm. wide, abruptly cuspidate-acuminate, the acumen 8–13 mm. long, narrow, acute, at base acute or attenuate, subcoriaceous, deep green above, glabrous, dull, the venation inconspicuous, beneath paler, minutely puberulous, the costa slender, salient, the lateral nerves very slender, prominulous, about 10 on each side, ascending at a wide angle, arcuate, extending nearly or quite to the margin, the intermediate nerves obsolete; inflorescence terminal, cymose-paniculate, open, sparsely branched, few-flowered, short-pedunculate, 4–5 cm. long and broad, the branches puberulent; bracts lance-oblong, green, 3–4 mm. long; pedicels 3–7 mm. long, glabrous, jointed at apex; hypanthium obovoid, 2–2.5 mm. long,

glabrous; calyx 4–6 mm. long, 5-lobate nearly to the base, green, glabrous, the lobes ovate-oblong, unequal, acuminate; corolla greenish purple, glabrous, funnelform, the tube 7–8 mm. long, 2 mm. broad at base, 3 mm. broad in the throat, the 5 lobes broadly ovate, obtuse, 4 mm. long, spreading.

Type in the U. S. National Herbarium, no. 677618, collected in humid forest between Alto de las Palmas and top of Cerro de la Horqueta, Chiriquí, Panama, altitude 2,100 to 2,265 meters, March 18, 1911, by H. Pittier (no. 3222). One other collection is at hand:

PANAMA: Top of Cerro de la Horqueta, alt. 2,265 m., *Pittier* 3237.

Palicourea pauciflora is well marked by the large calyx. From *P. macrocalyx* it differs in its small leaves with inconspicuous venation, and in the narrow acute calyx lobes.

Palicourea montivaga Standl., sp. nov.

Slender dense shrub 1.5–2.5 m. high, the branches subterete, green, glabrous, the internodes short, usually 0.5–1.5 cm. long, sometimes longer; stipules green, persistent, connate, 2–2.5 mm. long, bicuspidate, the cusps less than 1 mm. long; leaves opposite, the petioles slender, 7–15 mm. long, glabrous; leaf blades lance-oblong, 5.5–7 cm. long, 1–2 cm. wide, gradually or abruptly very long-acuminate, with acute tip, acute at base, thick-membranaceous, glabrous, deep green above, slightly paler beneath, the costa and lateral nerves slender, prominent, the lateral nerves about 9 on each side, arcuate-ascending, irregularly anastomosing near the margin, the intermediate nerves obscure; inflorescence terminal, cymose-paniculate, many-flowered, about 3 cm. long and broad, the branches ascending, greenish yellow, sparsely and minutely puberulent or glabrous, the peduncle 1.5–3 cm. long; lowest bracts linear, green, 1.5–2 mm. long, the upper ones shorter and broader, green; pedicels 2.5 mm. long or shorter, jointed at apex, some of the flowers sessile; hypanthium broadly turbinate, 1 mm. long, green, glabrous; calyx about 0.6 mm. long, 5-lobate to the base, the lobes broadly triangular, obtuse or acute, erect; corolla yellow or greenish yellow, glabrous, the tube 7 mm. long, slightly curved, enlarged at base, broadened above and 2.5 mm. broad, the 5 lobes broadly triangular, obtuse, 1.5 mm. long, spreading.

Type in the U. S. National Herbarium, no. 1,306,225, collected in wet forest at Yerba Buena, northeast of San Isidro, Province of Heredia, Costa Rica, altitude about 2,000 meters, February 28, 1926, by Paul C. Standley and Juvenal Valerio (no. 49850). The plant is represented by the following collections:

COSTA RICA: Yerba Buena, *Standley & Valerio* 49205, 49874. Cerro de las Caricias, alt. 2,300 m., *Standley & Valerio* 52107, 52226. Cerros de Zurquí, alt. 2,200 m., *Standley & Valerio* 50541, 50551.

From the species of *Palicourea* reported heretofore from Costa Rica, this is distinguished by its small leaves, small inflorescences, and short corolla.

Palicourea adusta Standl., sp. nov.

Weak shrub, 30–90 cm. high, usually decumbent, sparsely branched, the branches slender, subterete, green, the internodes 1–4.5 cm. long, sparsely pilose with short thick spreading hairs or glabrate; stipules persistent, green, short-connate, bicuspidate, the cusps linear, acute, green, 1–2.5 mm. long; leaves opposite, the petioles 6–10 mm. long, glabrous; leaf blades elliptic

to elliptic-oblong, 4–6 cm. long, 1.5–2.5 cm. wide, gradually or abruptly acuminate or long-acuminate, with obtuse or acute tip, at base obtuse or acute, firm, deep green above, usually marked with numerous linear pale cystoliths, at first puberulent on the costa but soon glabrate, beneath paler, when young pubescent with short, pale, appressed or spreading hairs, in age glabrate except on the principal nerves, the costa slender, prominent beneath, the lateral nerves very slender, evident, about 9 on each side, arcuate-ascending, extending to the margin; inflorescence terminal, cymose-paniculate, sparsely branched, many-flowered, the panicles 3.5–6 cm. long and nearly or quite as broad, the branches divaricate, sordid-puberulent, violet; bracts green, 2–4 mm. long, linear or subulate, acute; pedicels 1–2 mm. long, puberulent, jointed at apex; hypanthium rounded-turbinate, violet, 1–1.5 mm. long, sparsely puberulent or glabrate; calyx 5-lobate to base, the lobes less than 1 mm. long, unequal, broadly triangular or triangular-ovate, acute to obtuse and apiculate; corolla violet, 8 mm. long, the tube glabrous, enlarged at base, nearly straight, nearly 2 mm. broad, slightly broadened in the throat, the 5 lobes broadly ovate, 1–1.5 mm. long, obtuse or acutish, erect or ascending, obscurely puberulent on the margins.

Type in the U. S. National Herbarium, no. 1,253,350, collected in wet forest on Cerro de las Vueltas, Province of San José, Costa Rica, altitude 3,000 meters, January 1, 1926, by Paul C. Standley and Juvenal Valerio (no. 43666). The following additional collections are referred here:

COSTA RICA: Cerro de las Vueltas, *Standley & Valerio* 43780, 43908. El Páramo, Jan., 1897, *Pittier* 10486.

In general appearance this plant resembles *P. montivaga*, but that is a large shrub with narrower leaves and greenish yellow inflorescence. In habit *P. adusta* is unlike the other Central American species of *Palicourea*, which are tall erect shrubs.

Palicourea salicifolia Standl., sp. nov.

Slender shrub 1.5–3.5 m. high, glabrous throughout, much branched, the branches rather stout, subterete, the older ones ochraceous, the younger ones green, the internodes mostly 1–2 cm. long but often longer; stipules persistent, short-connate, deeply bilobate, the lobes linear, acute, green, 1.5–2.5 mm. long; leaves opposite, the petioles stout, 4–17 mm. long; leaf blades narrowly oblong to elliptic-oblong, 5.5–10 cm. long, 1.3–2.5 cm. wide, long-acuminate, with narrow obtuse acumen, at base acute to long-attenuate, thick and firm, deep green above, somewhat lustrous, beneath paler, the costa prominent beneath, slender, the lateral nerves very slender, about 13 on each side, divaricate at nearly a right angle, arcuate, irregularly anastomosing near the margin, the intermediate nerves obscure; inflorescence terminal, cymose-paniculate, many-flowered, about 4 cm. long and often much broader, the branches usually divaricate, the peduncle usually less than 1 cm. long; bracts green, linear to oblong or spatulate, usually obtuse, mostly 4–7 mm. long, but the upper ones often smaller; pedicels jointed at apex, in fruit sometimes 1 cm. long but usually shorter, bearing 1 or more small green bractlets; hypanthium broadly turbinate, 1.5 mm. long; calyx 1.5–2 mm. long, 5-lobate nearly to the base, the lobes oblong, oval, or broadly spatulate, rounded at apex, green; corolla not seen; fruit bluish green, subglobose, laterally compressed and bisulcate, about 6 mm. broad, the 2 pyrenes sharply 3-costate dorsally.

Type in the U. S. National Herbarium, no. 1,252,646, collected in wet forest at Laguna de la Chonta, northeast of Santa María de Dota, Province of San José, Costa Rica, altitude 2,000 meters, December 18, 1925, by Paul C. Standley (no. 42174). The following additional collections are at hand:

COSTA RICA: Laguna de la Chonta, *Standley* 42178. Near Finca La Cima, above Los Lotes, north of El Copey, alt. 2,100 to 2,400 m., *Standley* 42795, 42806, 42713, 42642.

In foliage characters this plant resembles *P. montivaga*, but it differs from that species in the large bracts of the panicles and in the larger calyx with very different lobes. The corolla has not been seen, and it may be that the plant should be referred rather to the genus *Psychotria*.

Cephaelis latistipula Standl., sp. nov.

Plants simple, 30–100 cm. high, suffrutescent, glabrous throughout, the stems stout, subterete, the upper internodes 2–3 cm. long; stipules distinct, rounded, 14–22 mm. long and nearly or quite as broad, persistent, thick and firm, conspicuously nerved, bilobate at apex, the lobes about 5 mm. long, acutish, undulate or shallowly and irregularly dentate, the sinus closed or nearly so; leaves opposite, the petioles slender, 2–7 cm. long; leaf blades oval-elliptic to broadly elliptic, broadest at or slightly above the middle, 14–21 cm. long, 7–9 cm. wide, rounded or very obtuse at apex and abruptly short-pointed, with acute tip, shortly narrowed to the acute base, chartaceous, deep green above, paler beneath, the costa stout, prominent, the lateral nerves 11 or 12 on each side, divergent at nearly a right angle, arcuate, faintly anastomosing close to the margin, the intermediate nerves obsolete; inflorescences axillary, capitate, dark red, very dense, many-flowered, sessile or nearly so, about 1 cm. long and 2 cm. broad; outer bracts broadly oblong, 7–8 mm. long, 4 mm. broad, obtuse, the inner bracts narrower, irregularly denticulate and ciliolate about the acute apex, the innermost bracts linear; flowers sessile, the hypanthium broadly turbinate, 1.5 mm. long; calyx 2–2.5 mm. long, deeply 5-lobate, the lobes lanceolate, long-acuminate, denticulate; corolla 5 mm. long, funnelform, the lobes spreading, triangular, acute or acutish, much shorter than the tube, short-villous within; anthers exserted.

Type in the U. S. National Herbarium, no. 1,153,168, collected in moist forest at Orosi, Province of Cartago, Costa Rica, March 30, 1924, by Paul C. Standley (no. 39695). One other specimen has been seen:

COSTA RICA: El Muñeco, Prov. Cartago, alt. 1,500 m., *Standley & Torres* 51252.

Cephaelis latistipula is a well-marked species, easily recognizable by its reduced stature, large leaves, broad stipules, and sessile heads.

Coussarea latifolia Standl., sp. nov.

Tree, glabrous throughout, the branchlets stout; stipules (of uppermost leaves) semiorbicular, 5 mm. long, intrapetiolar, short-connate, broadly rounded at apex, soon deciduous; petioles stout, 1.7–2.5 cm. long; leaf blades broadly elliptic-obovate to broadly ovate-elliptic, 16.5–25 cm. long, 9–16.5 cm. wide, rounded at apex and apiculate, acute or obtuse at base, papyraceous, concolorous, pale green when dry, the costa and lateral nerves stout, salient beneath, the lateral nerves about 9 on each side, arcuate-divaricate, irregu-

larly anastomosing close to the margin; inflorescence terminal, cymose-racemose, 6 cm. long, the peduncle 3 cm. long, compressed, the cymes 2 or 3-flowered, borne on ascending secondary peduncles 6–15 mm. long; bracts deciduous; pedicels stout, 1–4 mm. long; hypanthium obovoid, 4 mm. long; calyx tubular-campanulate, 5–7 mm. long, the limb truncate; corolla (in bud) yellowish white, the tube 1 cm. long, the 4 lobes linear-oblong, 13–15 mm. long.

Type in the U. S. National Herbarium, no. 938840, collected in forests of Tsaki, Talamanca, Costa Rica, altitude about 200 meters, April, 1895, by A. Tonduz (no. 9574).

The species is distinguished from other Costa Rican species of *Coussarea* by its large flowers and broad leaves.

Coussarea paniculata (Vahl) Standl.

Froelichia paniculata Vahl, Eclog. Amer. 3. 1796.
Coussarea froelichia A. Rich. Mem. Soc. Hist. Nat. Paris 5: 177. 1834.

Coussarea enneantha Standl., sp. nov.

Shrub 3 m. high, the trunk 3.5 cm. thick; young branches subterete, slender, the internodes 1–2 cm. long, densely fulvous-hirsute with short spreading hairs; stipules connate, forming a sheath 3 mm. long, hirtellous, tardily deciduous; petioles slender, 12–18 mm. long, densely short-hirsute; leaf blades elliptic-oblong, 9–12.5 cm. long, 3.2–5.3 cm. wide, abruptly acuminate with obtuse tip, at base acute or acutish, membranaceous, when young shortly fulvous-hirsute above along the nerves, glabrate in age, the venation prominulous, beneath green, hirtellous on the nerves, the costa and lateral nerves slender, prominent, the lateral nerves about 10 on each side, divergent at a wide angle, nearly straight, anastomosing toward the margin to form an irregular but distinct collective nerve, the intermediate nerves prominent, coarsely reticulate; inflorescence terminal, sessile, trichotomous, the branches slender, 2.8–3.8 cm. long, densely fulvous-hirsute with short spreading hairs, each branch 3-flowered at apex; pedicels 2–11 mm. long; bracts linear-subulate, 1–2 mm. long, deciduous; hypanthium obovoid, 2–3 mm. long, densely brown-hirtellous; calyx tubular, 8–9 mm. long, 2.5 mm. thick, hirtellous, the 4 lobes ovate-oblong, obtuse, over half as long as the tube; corolla white, the tube slender, 2.5 cm. long, sparsely pilose with slender spreading hairs, the 4 lobes linear, spreading, about 15 mm. long and 2 mm. wide, obtuse, sparsely hirtellous outside; fruit "white," not seen.

Type in the U. S. National Herbarium, no. 678317, collected in the vicinity of Cana, Panama, altitude 600 to 1,950 meters, April to June, 1908, by R. S. Williams (no. 841).

The proper position of this plant is very uncertain, but it seems to agree better with *Coussarea* than with any other group of Rubiaceae known from Central America.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

200TH MEETING

The 200th meeting was held jointly with the Chemical Society and the Philosophical Society in the Assembly Hall of the Cosmos Club on the evening of Thursday, May 28, 1925. Dr. H. FREUNDLICH of the Kaiser Wilhelm Institute at Berlin-Dahlem delivered an address on the *State of aggregation and form of colloid particles.*

201ST MEETING

The 201st meeting was held jointly with the Chemical Society in the Assembly Hall of the Cosmos Club on the evening of Friday, September 25, 1925. Dr. ALEXANDER FINLAY of the University of Aberdeen delivered an address on the *Appeal of science to the community.* The address is published in *Science*, Vol. 62, Oct. 23, 1925.

202D MEETING

The 202d meeting was held jointly with the Geological Society in the Assembly Hall of the Cosmos Club on the evening of Thursday, November 19, 1925.

Program: Dr. WILLIAM H. HOBBS of the University of Michigan, *The poles of the atmospheric circulation.* The two continental glaciers—the ice mantles which overlie the continents of the Antarctic and Greenland—possess each an autocirculation which is anticyclonic in character, but possessed of a vigor which removes it from all comparison with the so-called anticyclones of other areas. The circulations above the continental glaciers—the glacial anticyclones—are to be ascribed to the domed surface of the inland ice and to the excessive irradiation from the snow-ice surface throughout the year. Such irradiation being a function directly of time, a calm is favorable to the development of centrifugal surface movement of the air upon the domed surface. On the other hand, the descent of the air from the high interior of the continent brings about an adiabatic elevation of temperature, and since this is proportional to the vertical component of the air movement, the high velocity that is developed in the outflowing air currents tends to halt the flow with great suddenness and to restore the condition of calm. The weather above the continental glaciers is thus an alternation of calms with blizzards, which latter evolve gradually but terminate abruptly with rapid elevation of temperature—the foehn phenomenon.

The vigor of these powerful circulatory systems over areas that are measured in hundreds of thousands of square miles, is such as to extend the air movement up to near the ceiling of the troposphere and to include the cirrus level. Because of this vigor the central areas of the glacial anticyclones, instead of being dry and characterized by an excess of evaporation over precipitation, as is the case within the central areas of the shallow and inert migrating anticyclones, are regions of high relative humidity and of large precipitation of moisture in the form both of fine ice needles and of minute water droplets. The source of this moisture, amply confirmed by observation, must be ascribed to the water which was locked up in the ice needles of

the cirri and of other high-level clouds, this moisture being first melted and later vaporized adiabatically during its descent to the glacier surface.

The two glacial anticyclones of the earth, one centered relatively near, though not over, the southern geographic pole, and the other centered fully nineteen degrees of latitude from the northern pole, are thus the wind poles of our atmospheric circulation. The north polar area itself, as is clearly shown by observations, is an area of monotonously normal barometric pressure, of relatively warm air, of shifting wind direction, and of high humidity.

The continental glaciers with their overlying fixed glacial anticyclones are the two marked refrigerating regions within our atmospheric envelope, and their function in stimulating the circulation is comparable in importance to that of the heating belt of high insolation near the equator. The strong development of climatic zones in the present geological period must be ascribed to the contributory action of the refrigerating engines in developing the present vigor of the atmospheric circulation; for, if we consider the geologic past, the present is an altogether abnormal period, climatically considered, of the earth's history. As has been clearly shown by David White and F. H. Knowlton, the distribution of delicate plant organisms during the geologic past, since at least the early Paleozoic, shows that no strongly developed climatic zones have existed save only during the Permian and Pleistocene periods, with which later period the present is climatically included. It is of the greatest significance, therefore, that these exceptional periods of climate in the earth's history are the only ones of which it is known that continental glaciers existed which, through their refrigerating effect, could have stimulated to unusual vigor the circulation within the atmosphere. (*Author's abstract.*)

203D MEETING

The 203d meeting was held in the Assembly Hall of the Cosmos Club on the evening of Thursday, December 17, 1925. Dr. ERWIN F. SMITH of the Department of Agriculture delivered an address on *Recent views as to the cause of cancer.*

The address dealt with some of the newer researches on cancer and was substantially the same as that prepared for the New Haven Symposium, which appeared in *The American Naturalist*, May-June, 1926. The author was inclined to believe, with Gye and Blumenthal, that cancers are due to one or more parasites, but he also gave quite fully other views as to causation, namely, the irritation hypothesis and the views of Warburg of Berlin and Burrows of St. Louis.

204TH MEETING

The 204th meeting, the 28th Annual Meeting and a joint meeting with the Anthropological Society, was held in the Administration Building of the Carnegie Institute of Washington on Tuesday, January 12, 1926, with President JUDD of the Anthropological Society in the chair. The program consisted of an address by Dr. BYRON CUMMINGS, Director of the State Museum and Professor of Archeology, University of Arizona, on the subject, *Certain metal objects found near Tucson, Arizona.* A brief abstract of his address follows the minutes of the annual business meeting.

A short intermission followed his address, after which the annual business meeting was held.

The minutes of the 27th Annual Meeting were read and approved.

The Corresponding Secretary, F. B. SILSBEE, reported briefly on the activities of the ACADEMY during 1926. During the year 1925, 24 persons were elected to regular membership, 18 of whom had accepted and qualified during the year, and one of whom had declined. Thirty who had been elected before January 1, 1925, also qualified. Six resignations were accepted, and three members were dropped for non-payment of dues. Eleven deaths occurred among the members, as follows: J. C. BRANNER, E. D. CAMPBELL, MITCHELL CARROLL, T. L. CASEY, D. T. DAY, W. F. HILLEBRAND, W. D. HUNTER, W. G. MILLER, B. H. RANSOM, T. L. WATSON, J. B. WOODWORTH.

The Board of Managers held five meetings devoted mainly to routine business. The list of *One hundred popular books on science* was revised, and the biennial directory was issued. The report was ordered accepted and filed.

The report of the Recording Secretary, WALTER D. LAMBERT, was read. There were held during the year ten public meetings, many of them jointly with one or more affiliated societies. The names of the affiliated societies and of the speakers, and the titles of the addresses and additional items of interest, were given. The report was ordered accepted and filed.

The report of the Treasurer, R. L. FARIS, was read. It showed total receipts of $5,485.39 during the year, and total disbursements of $5,970.01. The value of the ACADEMY'S investments was $17,036.37, cash on hand was $2,656.18, and the estimated net worth $19,187.83.

The report of the Auditing Committee, consisting of N. H. HECK, V. K. CHESNUT and D. L. HAZARD, was read, verifying the Treasurer's figures. The reports of the Treasurer and the Auditing Committee were then accepted.

The report of the Editors of the Journal was presented by E. P. KILLIP, Senior Editor. It detailed the distribution of the articles in the various fields of science, and noted a slight increase in the cost per page over the preceding year. The effort to obtain articles in as wide as possible a field of scientific interest was continued. The report was ordered accepted and filed.

The report of the Committee of Tellers, F. B. SILSBEE, G. W. VINAL and E. R. WEAVER, was presented by the chairman. In accordance with the report, the following officers were declared elected: *President*, G. K. BURGESS; *Non-resident Vice-Presidents*, RAYMOND PEARL, W. W. CAMPBELL; *Corresponding Secretary*, FRANCIS B. SILSBEE; *Recording Secretary*, W. D. LAMBERT; *Treasurer*, R. L. FARIS; *Manager, Class of 1929*, A. H. CLARK, L. A. ROGERS.

The following Vice-Presidents nominated by the affiliated societies were then elected: *Archeological Society*, WALTER HOUGH; *Society of American Bacteriologists*, W. D. BIGELOW; *Biological Society*, H. C. OBERHOLZER; *Botanical Society*, R. KENT BEATTIE; *Chemical Society*, F. W. SMITHER; *Institute of Electrical Engineers*, A. R. CHEYNEY; *Entomological Society*, A. G. BÖVING; *Society of Foresters*, G. B. SUDWORTH; *Geographic Society*, F. V. COVILLE; *Helminthological Society*, H. C. HALL; *Historical Society*, ALLEN C. CLARK; *Mechanical Engineers*, H. L. WHITTEMORE; *Philosophical Society*, PAUL R. HEYL.

At 10.15 P.M. the meeting adjourned.

Dr. BYRON CUMMINGS, *Certain metal objects found near Tucson, Arizona.* In September, 1924, Mr. Charles E. Manier and his father, while inspecting an old lime-kiln about nine miles northwest of Tucson, noticed a bit of metal projecting from the side of the trench that had been cut through the formation

to open an entrance to the bottom of the kiln. On digging away the gravel and caliche in which it was embedded, the object proved to be a cross made of lead alloy. It had been cast in a crude mold on the surface of ground over which were scattered fragments of ore, caliche and gravel. Made in two parts, the inside of each half had been smoothed and engraved with inscriptions in Latin.

Excavations were then made to the right and to the left of this trench by Mr. Thomas Bent, who owns the land, and Mr. Manier. Scattered over considerable area at between two and a half to six feet below the surface have been found four other double and three single crosses. Besides these crosses there have been uncovered three swords and four parts of swords, three spears and two spear heads, and a peculiar paddle-shaped object that may be called a labrum. All of these are more or less engraved with inscriptions in Latin and various symbols and drawings. On the two unusual crosses entwined with serpents are found some Hebrew inscriptions and symbols.

None of this superimposed material shows any evidence of having been disturbed since laid down by natural forces. All of these articles were found embedded in caliche and gravel at practically the same level. This caliche is a lime crust formed irregularly through sand and gravel deposits by the leaching of the calcareous material from the superimposed and surrounding soil and rock. It settles into pockets, spreads out into sheets and cements the sand and gravel together in hard masses that can be broken up only by a sharp pick or a charge of dynamite. Many of these objects were embedded in part or the whole in this solid caliche and could be removed only by vigorous effort with a good pick. Some lay in pockets or thin strata of sand which were overlaid with strata of caliche. Lenses of gravel and sand extend along horizontally above these articles which, if they had been "planted" in recent years and the holes filled up with caliche and gravel, would be broken and the lines of demarcation readily distinguishable.

The articles are made of a lead alloy. Assays show lead and antimony with traces of tin, gold, silver and copper. Ores of this character are mined in the Tucson mountains, a few miles away, and in other mountains further away to the south. The ores have probably been crushed and crudely smelted, the metals puddled and then used in the manufacture of these weapons and emblems. All are crudely fashioned and show such work as you might expect to be produced by men in the desert country of Arizona, with few tools and no mechanical appliances.

The Latin is the capital script that was in common use for records and religious inscriptions up to about the eighth century A.D. The words are separated by dots, and the construction follows that of the classic Latin of Caesar and Vergil. One would judge that they had been carved by one who had a limited knowledge of classical Latin and had woven expressions with which he was familiar into the record he desired to make. The Hebrew inscriptions on the two serpent swords are words and expressions such as "Jehovah," "peace," "mighty empire," etc.

On the face, these evidences would indicate the work of men who, slightly versed in classical Latin, Roman affairs and Jewish history, wished to record this evidence to astonish their contemporaries. But would any people, one or more centuries ago in this remote region, have had time or means or desire either to hoodwink other men by their show of learning or to deceive posterity? The white men who lived in and traversed this region even fifty

years ago had very little time for fun or fiction of this elaborate character, if any possessed the ability to manufacture or inscribe these articles. The problem remains unsolved. (*Condensed from author's manuscript.*)

205TH MEETING

The 205th meeting was held jointly with the American Institute of Electrical Engineers (Washington Section) in the Assembly Hall of the Cosmos Club on the evening of Tuesday, March 9, 1926.

Program: Dr. GEORGE C. SOUTHWORTH, of the American Telephone and Telegraph Company, *Some interesting things about radio transmission.* The electromagnetic waves used in radio transmission differ from light only in wave length. Both represent a power transfer, and the intensity of either may be measured by the electric field strength or by the power propagated through a given area. A simple picture of a radio wave may be developed from the Faraday conception of lines of electric and magnetic force. This view is furthermore consistent with other phenomena, such as power flow in a simple battery circuit or an electric light line, or the propagation of speech energy over a telephone circuit.

The power per unit area propagated in a broadcast signal of ordinary strength is so small as to be measured in millionths of a watt per square meter. In addition to propagating power a broadcast wave exerts a pressure on conducting objects on which it happens to fall. This pressure has been computed and is found to be extremely small. Thus the total force due to waves impinging on a tall skyscraper seldom exceeds a millionth of a millionth of a pound.

There is a threshold value below which the human eye will not respond to light. If this value is interpreted in terms of the units used in measuring broadcast signals, we find that the eye is only a hundredth or a thousandth as sensitive as a good radio receiver. The sun sends to us relatively strong electric waves. These are of the order of a million times as intense as those used in radio communication and amount to perhaps 7.5 volts per centimeter.

When radio waves such as employed for transatlantic telephony are propagated over considerable distances, their intensity is impaired on account of both the spreading of the wave energy into greater space and the attenuation caused by the terrain over which they pass. This attenuation is less when the waves pass over water than over land. If the transmission be over relatively great distances, the attenuation undergoes wide changes throughout the 24 hours. At night it is sometimes so little as to permit of transatlantic communication with relatively small amounts of power, but in daylight, it may be so great as to require hundreds of kilowatts of transmitting power. The change in the received signal caused by this varying attenuation is known as its diurnal variation and has been quite thoroughly studied by Bell System engineers in connection with transatlantic telephony.

The utility of radio waves as vehicles of intelligence is determined not only by their intensity but also by the amount of interfering noise, making the ratio of signal-to-noise of great importance. This ratio for transatlantic communication is a maximum during the hours when darkness prevails over the path between England and America, and has a very definite minimum during the late afternoon when the wall of darkness is passing from England to America. On account of the five hours' difference in the standard times used in Europe and in America, the business days overlap but a few hours during our forenoon. If a commercial telephone circuit were to be set up

between England and America, probably it would be during these hours that the circuit would have its greatest usefulness. It happens that they come at a time when transmission is neither very good nor very bad.

When radio is used for broadcasting, its interest is frequently a local one, in which case diurnal variation is not of great importance, but there are local effects which are important. For instance, when broadcast waves pass over metropolitan areas, they are sometimes seriously distorted and very definite shadows are produced in which the signal strength is much reduced. Furthermore, in these areas the quality of reproduced speech may be injured, while that just outside the shadow may be excellent. This quality distortion has been improved by stabilizing the transmitter so that only the very smallest frequency changes can result. Although pronounced shadows have been noted in the vicinity of New York City, the transmission over Washington, D. C., seems to be very normal. (*Author's abstract.*)

206TH MEETING

The 206th meeting was held jointly with the Philosophical Society and the Chemical Society in the Assembly Hall of the Cosmos Club on Thursday, March 18, 1926.

Program: Dr. EDWIN E. SLOSSON, Editor of Science Service, *The chemical interpretation of history.* If we can find out the laws of biochemistry we can not only improve the present generation and control the future but interpret the past. The historian in the light of these laws will be able to tell what happened and why. History will then cease to be a mere chronicle and become part of the science of human behavior. Astronomy was for the first five thousand years a mere observational science, but now has become the extra-mundane branch of physics and chemistry.

Historians record the rise and fall of races. They point out that the decline is often due to a lowering of the birthrate and they ascribe this to various causes, moral, financial, political or social. These are plausible surmises, yet it may be that the real cause was a lack of vitamin E. It might happen that a people or clan or class might die out suddenly through a change of diet, while seemingly well nourished and as vigorous as ever. Until this factor is taken into consideration a charge of race suicide must be held not proven in spite of what the moralists may say.

Why does India present such a strange spectacle in the decline of the vigorous races that have successively invaded the country in past centuries? Why does the conquering caste lose its stamina in a few generations? The cause commonly adduced is the climate, the excess of sunshine? Possibly—and possibly the lack of it. We must take into consideration the "purdah disease." The seclusion of the women and children of the aristocratic classes keeps them in the shade. May not one of the causes of racial decay in India be lack of Vitamin D, which is induced by sunshine and is essential for bone formation?

If you belong to the school of historians which holds that the human factor is all important, that history is merely a chain of biographies of the great men of each generation, then here also chemistry may supply the key. For instance, even the historians who lay most stress upon the climatic and economic factors must admit that the course of the world's history was materially affected by the personal peculiarities and temperament of Napoleon Bonaparte. But all histories agree that the Little Corporal at Lodi was a very different person from the Emperor at Waterloo; different in disposition, enterprise and ability. And no wonder, for his chemical composition had

changed in the nineteen years between. He was as unlike his former self as carbolic acid is unlike sugar although they are composed of the same elements.

And in science explanation is the first step toward control. The oldest, most stable, most democratic, and within their limitations most efficient commonwealths in the world have adopted chemical methods of political and industrial management. These are the ants and bees, where the workers have been in absolute control for some five million years. They do not choose the head of the state by popular vote from among their own number as is done in representative governments like ours. They get a fit ruler by feeding. When the workers decide by their silent plebiscite that a new queen is needed, they make one to order.

Then there is the climatic theory of history: that the capacities and activities of a people are due to the effects of climate. But what does the climate affect? Obviously the chemical composition and balance of the body through temperature, humidity, pressure, sunshine, diet and mode of life.

The laws of heredity are concerned solely with the combinations of the determinants in the germ plasm. But what determines the determinants? Obviously the difference in their chemical composition. Some day we may find out their chemical structure. Some day we may be able to alter it. Already it has been found possible by means of X-rays to reach the factors of heredity inside the germ cell and so to transform them as to produce strange creatures, such as have never appeared in nature, and this is not only in the first but in the second generation. Such synthetic animals are mostly monsters, but might it not happen that improved species could be produced in some such way? (*Condensed from author's manuscript.*)

207TH MEETING

The 207th meeting was held jointly with the Philosophical Society and the Biological Society in the Assembly Hall of the Cosmos Club on the evening of Thursday, April 15, 1926, with President BURGESS in the chair. On behalf of the New York Geographical Society, Major-General Charles McK. SALZMAN presented the Charles P. Daly medal to Brigadier General DAVID L. BRAINARD, retired, for his Arctic explorations. General Brainard accepted with a few words of thanks. Major General A. W. GREELY, retired, gave some reminiscences of Arctic exploration and of his association with General Brainard.

Acting for the Secretary of the Navy, Capt. W. S. CROSSLEY presented the Cullom Geographical Medal to Dr. HARVEY C. HAYES for his discoveries in acoustic sounding. Dr. Hayes accepted with a short address of thanks.

Program: Dr. PAUL R. HEYL, of the Bureau of Standards, *Visions and dreams of a scientific man.* Contrary to a rather widely current idea, science and scientific men are not purely matter of fact and prosaic. There is a human, even a poetic side to the study of Nature. The visions which Nature presents to us contain the three characteristic features of poetry: the lyric, the epic, and even the tragic. In addition, they contain what is often lacking in the dreams of the poet and the mystic—an element of reality. (*Author's abstract.*)

208TH MEETING

The 208th meeting was held jointly with the Philosophical Society and the Chemical Society in the Assembly Hall of the Cosmos Club on the evening

of Saturday, May 29, 1926. Professor ERNST COHEN of the University of Utrecht delivered an address *The metamorphosis of matter and the alleged constancy of our physico-chemical constants.*

209TH MEETING

The 209th meeting was held jointly with the Smithsonian Institution, the Carnegie Institute and the Biological Society in the auditorium of the National Museum at 10th and B Streets on Friday, June 4, 1926. Dr. ALEXANDER WETMORE of the Smithsonian Institution presided. Dr. JOHANNES SCHMIDT of the Carlsberg Laboratories, Copenhagen, delivered an address on *Danish oceanographic expeditions and investigations of the life history of the eel.* After the address President BURGESS of the Academy announced that Dr. Schmidt had been elected an honorary member of the Academy and presented him with a diploma of membership.

210TH MEETING

The 210th meeting was held jointly with the Chemical Society in the Assembly Hall of the Cosmos Club on the evening of Thursday, December 16, 1926. Dr. LOUIS C. HEILAND for the Board of City Trusts of Philadelphia conferred on Dr. HARVEY C. HAYES the John Scott Medal, the actual delivery being made by Mr. E. C. WARNER, Assistant Secretary of the Navy, who made a brief presentation address.

Program: Professor J. N. BRÖNSTED, of the University of Copenhagen, *The metal amines and their significance for the physical chemistry of solutions.* The study of metal amines has played a considerable rôle in the theory of the structure of inorganic compounds. It promises to have a similar significance for the theory of solutions.

Cations as well as anions are known in great numbers in this group. They combine to form salts which have as a rule characteristic and well defined properties, raging in solubility from about 10^{-5} to 1 mol per liter. These salts are very suitable for a study of the solubility laws of electrolytes and have been so used to a large extent. Such data have been of service in verifying the laws of the activity coefficient in dilute solution.

The complex metal amines may contain anions in complex combination with the central metal atom. In many such cases the anion is split off in aqueous solution with measurable speed (aquotation). The reverse reaction is also measurable. These data are very useful in building up the recent theory of the statics and kinetics of ions.

The usefulness and applicability of the definition of acids and bases by the scheme

$$\text{Acid} \rightleftharpoons \text{Base} + \text{H}^+$$

is exemplified in a number of cases in this group of compounds. When water instead of ammonia enters the complex ion, the ion becomes an acid, one of the H atoms in the H_2O molecule being partially split off as H^+. The behavior of such metal amine ions verifies the idea of the significance of the electric charge in determining the acidic or basic character of the molecule.

Basic metal amine ions are of highly catalytic effect upon the decomposition of nitramide. The high positive charge of such ions may be expected to throw some light upon this peculiar catalytic reaction.

The aquotation of the various complex ions follows widely different laws. In some cases the velocity is independent of the H^+ concentration, in other cases extremely sensitive toward it. This phenomenon can be explained on

the basis of the different acidity of the ions involved in combination with the effect of the electric charge. This explanation may be of value in many similar cases in other fields of investigation, where the presence of small amounts of acid shows a stabilizing effect. (*Author's abstract.*)

WALTER D. LAMBERT, *Recording Secretary.*

PHILOSOPHICAL SOCIETY

969TH MEETING

The 969th meeting was held at the Cosmos Club February 4, 1928.

Program: W. G. BROMBACHER: *Instrument technique in aircraft flights for international records.* Aircraft flights for international records are made under rules and regulations promulgated by the Fédération Aéronautique Internationale (F. A. I.), the United States member of which is the National Aeronautic Association (N. A. A.). Instruments carried in such flights are submitted to the Bureau of Standards for calibration tests, which certifies the results of such tests to the N. A. A. Of the various types of records such as duration flights, greatest speed and highest altitude with and without useful load, the instrumental problems relating to the highest altitude are of the most interest. The rules provide that one or two sealed barographs be carried in order to determine the lowest pressure reached in the flight which is converted to altitude by use of the altitude-pressure relation of the F. A. I. standard altitude. The method of calibration has consisted in subjecting the barograph to a "flight-history" test in which the temperature and pressure are controlled so as to approximate the flight conditions both as to the values and the rates of change. The pressure in the bell jar in which the instrument is placed is controlled so that the pen of the instrument follows the trace made during the flight. Coils in the bell jar through which carbon dioxide is expanded, enable the reduction of the instrument temperature to values as low as −48°C. The pressure when the pen is on the trace at the ground level and at the highest level is measured by means of a mercurial barometer. The difference in these two pressures when subtracted from the pressure at the ground level at the time of the flight gives the lowest pressure attained. This method of calibration, when certain precautions are observed and assuming the use of first quality barographs, enables the lowest pressure to be determined with an accuracy of 1 to 3 millimeters of mercury. The F. A. I. regulations now in force are far from ideal from a scientific point of view. This country through the N. A. A. has submitted modifications which if adopted will insure more satisfactory results. The lack of complete testing facilities in most of the countries has no doubt prevented adoption of these modifications. (*Author's abstract.*)

A. H. BENNETT: *Recent methods for the measurement of aberrations of telescope objectives.* The failure of geometric optics to explain the light distribution in a star disc is pointed out. Physical optics explains the effects at the focus of a telescope objective in a satisfactory manner. Methods of measuring aberrations of a lens system are divided into two classes, geometric and interference methods, with the results expressed in terms of geometric or physical optics, respectively. The Hartmann geometric method and its modifications, by Merland and by Kingslake, are discussed.

The interference methods of Waetzmann and of Twyman, and the modication of the Hartmann method based on interference by Gardner and Bennett are described. The details of an extension of the latter method,

as applied by the author to several astronomical objectives, are presented. Some results of this method are shown in the form of phase contours. (*Author's abstract.*)

F. WENNER: *A seismometer employing electromagnetic and optical magnification, and electromagnetic damping.* The seismometer was designed for use with a particular galvanometer of the fluxmeter type; that is, a galvanometer having a fairly long period and very high damping when the externally connected resistance is low. When the average value of the impressed e.m.f. is zero and the rate of change is not excessively high or excessively low, such galvanometers give deflections approximately proportional to the time integral of the e.m.f. The e.m.f. impressed upon the galvanometer is developed in a winding attached to the steady mass of the seismometer and so is proportional to its rate of displacement. Therefore the time integral of the e.m.f. is proportional to the displacement of a steady mass with respect to its support. Consequently the performance of the apparatus approximates that which would be obtained with a direct mechanical connection between the steady mass and the mirror which produced the record photographically. However, for very short period displacements such as are caused by traffic and very long period tilts caused by temperature changes, there is practically no response.

Magnification. Magnification of earth displacements of periods corresponding to the initial phases of distant earthquakes is high, somewhat more than 1000. In the range of periods of earth displacements from 2 1/2 to 30 seconds, the magnification decreases as the period increases as it does with the usual type of seismometer having the same free period and critical damping. Further, the period of earth displacements for which the magnification is a maximum is practically independent of the period of the seismometer and the stiffness of the suspensions of the galvanometer coil.

Damping. The damping both of the seismometer and of the galvanometer is brought about by the use of a single bridge or shunt across the line connecting these two units instead of by the use of additional magnets and a copper plate located on the seismometer, and the use of a suitable resistance in the galvanometer circuit. The period is determined and the damping adjusted from the position of the galvanometer, which normally would be in a room other than that in which the seismometer would be located and might well be in another building. The steady mass is displaced by the momentary passage of a small current through the winding of the seismometer. This current is led to and from the system at two points so selected that the electric circuit constitutes a balanced Wheatstone bridge with the galvanometer in its normal position. If then the bridge or shunt is opened, the electromagnetic damping is practically removed so the period may be observed by noting the time between turning points of the deflection of the galvanometer. If the bridge is not open, it may be adjusted so as to critically damp the entire system, as shown by the deflections of the galvanometer.

Coupling. The electromagnetic coupling between the galvanometer and the seismometer is very close. If the steady mass of the seismometer is held against one of its limiting stops, the damping of the motion of the galvanometer is approximately ten times critical. It is this close coupling or excessive over-damping of the galvanometer which is responsible for operating characteristics differing materially from those of apparatus of the Galitzin design.

Design. In the design an effort was made not only to produce an instru-

ment having improved operating characteristics but one of simple construction requiring but few adjustments of a type easily made.

Records of several earthquakes have been obtained and some of these show both the initial and later phases very nicely. (*Author's abstract.*)

970TH MEETING

The 970th meeting was held in the Cosmos Club February 18, 1928.

Program: H. L. DRYDEN and G. C. HILL: *Wind pressures on cylinders.* The Bureau of Standards has been engaged in the measurement of wind pressures on cylinders in the neighborhood of the critical region in which the field of flow changes character, with a view toward determining coefficients applicable to large chimneys. After a survey of experiments on the flow about cylinders of all sizes and speeds, attention was focused on the critical region and the results of pressure distribution measurements. The principal changes in the pressure distribution at the critical region are as follows:

1. The zonal angle at which the pressure equals the static pressure decreases by several degrees.
2. The maximum value of the decrease in pressure nearly doubles.
3. The mean value of the decrease in pressure over the rear quarter decreases greatly.
4. The resultant force coefficient decreases by more than 50 per cent.

The results of wind tunnel measurements can not safely be applied to large chimneys because of the large extrapolation required. Some preliminary observations on a 10-foot stack in the natural wind were mentioned as indicating the persistence of the low values of the resultant force coefficient. (*Author's abstract.*)

F. W. STEVENS: *The gaseous explosive reaction at constant pressure.* Thermodynamic studies of the gaseous explosive reaction have been made under conditions of constant volume. In these studies a spherical steel bomb with central ignition was found the most effective. The speaker called attention to the advantages of the use of constant pressure methods in the study of gaseous reactions and pointed out the possibility of realizing this condition in the case of gaseous explosive reactions by the use of temporary soap film containers likewise fired from the center. This unusually simple and easily manipulated device is found to function as a bomb of constant pressure (not necessarily atmospheric). It therefore provides the complement to the bomb of constant volume in the relation

$$pv = nRT$$

By either method, the final pressure or the final volume, as the case may be, corresponds to the equilibrium constant of the reaction for that condition.

$$K = \frac{A'^{n'_1} B'^{n'_2} C'^{n'_3} - - - -}{A^{n_1} B^{n_2} C^{n_3} - - - -}$$

The deviation from this constant due to the presence of an inert gas in the zone of explosive reaction permits the specific heat of gases to be determined at the temperature of the reaction. Likewise from the final pressure or the final volume corresponding to the equilibrium constant K, the degree of dissociation of the combustion products CO_2 and H_2O may be determined over wide ranges of temperature and pressure.

The application of constant pressure methods to the study of explosive gaseous reactions, made possible by the bubble device, led to the discovery of an interesting kinetic relation connecting the rate of propagation of the zone of explosive reaction within the active gases with the concentrations (partial pressures) of those gases. It was found that the rate of propagation, s, of the zone of reaction measured relative to the active gases, is proportional to the product of the initial concentrations (partial pressures) of those gases:

$$s = k_1 A^{n_1} B^{n_2} C^{n_3}$$

This fundamental kinetic relation found to exist between the rate of propagation of the zone of reaction within the active gases and the concentration of those gases, is further found to bear much the same relation to the kinetics of explosive gaseous reactions as does the fundamental thermodynamic relation expressed by K bear to the thermodynamics of the reaction. That is, the deviations from this kinetic expression due to the presence of an inert gas in the zone of reaction may be analyzed and interpreted by it, as may also the effect of known mixtures of active gases and the effect of pressure. (*Author's abstract.*)

971ST MEETING

The 971st meeting was held at the Cosmos Club March 3, 1928.

Program: F. M. DEFANDORF: *The corona voltmeter.* The definiteness of the voltage at which corona glow appears at the surface of round wires connected to an alternating voltage source led Prof. J. B. Whitehead to utilize this property in the design of a device for measuring the crest value of alternating voltage, that he called the Corona Voltmeter. It consists of a grounded outer cylindrical electrode and a polished concentric inner electrode which is connected to the high voltage source. Aural detection of corona formation was used in preference to visual and ionization methods. Initial corona formation has been shown to be a function of the inner and outer cylinder radii, the temperature of, pressure of, and kind of gas surrounding the electrodes. Dr. H. B. Brooks modified Whitehead's corona voltmeter by providing more accurate control of pressure, temperature, and humidity, previous to its calibration at the Bureau of Standards, where it was found that fouling the corona forming surface with a very small amount of impurity (cylinder oil) altered the corona voltage appreciably. With the surface in an undisturbed "cleaned" condition check readings to within 0.02 per cent could be made. Increase in humidity may raise or lower corona voltage by as much as 3 per cent depending on the size of rod and gas density. The observed data were shown to be in fair agreement with a modified law of corona, and a monogram designed by Brooks for rapid determination of corona voltage from the pressure and temperature measurements for dry air was shown. The apparent superiority in accuracy of the corona voltmeter over the sphere gap was discussed briefly.

W. P. WHITE: *Some surprising adsorption effects.*

RALPH E. GIBSON: *The influence of pressure on the high-low inversion of quartz.* The temperature at which quartz inverts from the low to the high form is raised by the application of a uniform hydrostatic pressure. From observations made at pressures from 1 to 3000 megabaryes the rise in the inversion temperature is given as the following function of the pressure:

$$T = -0.3 + 2.1 \times 10^{-2} p + 8.6 \times 10^{-7} p^2$$

From these results the latent heat of inversion and the specific heat of low quartz are calculated.

Underlying the calculation of the specific heat of low quartz are two assumptions which are justified from considerations of the nature of the inversion. (*Author's abstract.*)

H. E. MERWIN, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

Dr. E. G. ZIES of the Geophysical Laboratory will spend several months in the Dutch East Indies, in a study of the gases and other volatile products of the volcanoes of that region. Messrs. E. T. ALLEN and C. N. FENNER will spend the summer in a chemical and geological study of the geysers and hot springs of the Yellowstone National Park.

Two lectures supplementary to the annual series of the Carnegie Institution of Washington were given in April. The lecturers and their subjects were: April 18, FRANCIS G. BENEDICT, Director of the Nutrition Laboratory, *Basal metabolism, the modern measure of vital activity;* April 20, CHARLES B. DAVENPORT, Director of the Department of Genetics, *Race crossing in Jamaica.*

The Petrologists' Club met at the Geophysical Laboratory on April 17. H. G. FERGUSON described the *Gold quartz veins of the Allegheny region, California;* G. W. MOREY gave a *Review of the critical phenomena in polycomponent systems.* Officers for the next season were chosen, as follows: *Secretary-Treasurer,* G. TUNELL; *Steering Committee,* D. F. HEWETT, F. C. SCHAIRER, W. T. SCHALLER.

At the April meeting of the Anthropological Society, NEIL M. JUDD, Curator of American Archeology, U. S. National Museum, the retiring president, delivered an address on *The present status of archeology in the United States.*

At the meeting of the National Academy of Sciences on April 23, 24, and 25 the following papers were read by Washington scientists: R. M. LANGER and GERALDINE K. WALKER, *Models of the Schrödinger atom;* E. O. HULBURT, *Ionization in the upper atmosphere of the earth;* FRANK WENNER, *A seismometer employing electromagnetic and optical magnification and electromagnetic damping;* DAVID WHITE, *Algal deposits of Unkar Proterozoic age in the Grand Canyon, Arizona;* HENRY S. WASHINGTON, *The bearing of the Pacific lavas on the question of the Atlantic and Pacific rock clans;* ALEŠ HRDLIČKA, *Traces of prehistoric man in Alaska;* JAMES W. GIDLEY, *Additional evidence on Pleistocene man in Florida;* WALTER T. SWINGLE, *Metazenia in the date palm, possibly a hormone action exerted by the endosperm;* CHARLES F. CRAIG, *Observations upon complement fixation in infections with Endamoeba hystolytica.* ARTHUR KEITH, U. S. Geological Survey, was elected to membership in the Academy.

Dr. J. WALTER FEWKES made the presentation address at the unveiling of the bust of Louis Agassiz at the Hall of Fame in New York, May 10. Dr. Fewkes was a pupil of Agassiz.

Dr. C. POULSEN, Mineralogical Museum, Copenhagen, is spending April and May at the National Museum in connection with his study of the Silurian fossils collected in North Greenland by Dr. Lauge Koch.

A. A. BAKER, U. S. Geological Survey, has left Washington to continue work on the geology of southeastern Utah, and C. H. DANE, of the same organization, is studying the geology of the southeastern part of the San Juan Basin, northwestern New Mexico.

H. W. HOOTS has recently resigned as a geologist in the U. S. Geological Survey to engage in commercial geology.

Obituary

Dr. JOSEPH NELSON ROSE, a member of the Academy, died May 4, 1928. He was born in Union County, Indiana, January 11, 1862, and educated at Wabash College. In 1888 he came to Washington as assistant botanist in the Department of Agriculture, and on the reorganization of the National Herbarium in 1896, and its transfer to the custody of the Smithsonian Institution, became assistant curator, and later associate curator, which position he held at the time of his death. Dr. Rose made extensive botanical explorations in the American tropics and in the Andes, particularly in connection with his monographic study of the cactus family. He is the author of a large number of papers on systematic botany, extending over a period of forty years. Aside from a series of papers on the flora of Mexico, his principal publications have dealt with the Apiaceae and several groups of succulents.